

## In this Issue

# A landmark study finds that when we look at sad faces, the size of the pupil we look at influences the size of our own pupil

We often mirror other people's behaviors, and one philosophical and psychological line of theories (Carruthers and Smith, 1996; Lipps, 1907) has long proposed that doing so allows us also to mirror other people's minds. Phenomena such as emotional contagion, imitation and other kinds of mimicry have been argued to constitute ontogenetic and phylogenetic precursors from which empathy, simulation and other abilities emerge in adult humans whereby we gain knowledge about the feelings, intentions and thoughts of others (Meltzoff and Decety, 2003). Neurobiological and psychophysiological data provide examples supporting this idea (Blakemore and Decety, 2001; Gallese *et al.*, 2004; Goldman and Sripada, 2005), but the details remain poorly understood and the theories remain debated (Adolphs, in press; Jacob and Jeannerod, 2005; Saxe, 2005).

In a study certain to become a classic, Harrison *et al.* (page 5) have demonstrated a role for pupil size in such mirroring. Their data are impressive: behaviorally, the pupil size of sad faces influences viewers' emotion judgments of the face, even in the absence of explicit awareness of the observed pupil size; the effect is correlated with regional brain activation of structures known to mediate emotions; and, perhaps most surprisingly, viewers' own pupils mimic the size of the pupils seen in the sad faces. Taken together, the findings argue that pupil size is a social signal that can communicate emotions empathically—presumably one that evolved to operate at very close range.

Pupil size is well-known to be influenced by stimulus luminance, but it turns out also to be influenced by other factors, including salience and emotional meaning. Owners of cats will have noticed large changes in their pupil size in response to stimuli such as a toy mouse or the sound of another cat. Such pupil changes in humans seem less common in our everyday experience, but may nonetheless influence our social judgments even when we do not notice them—an effect utilized in the 17th century by women through the use of atropine-containing eyedrops to dilate their pupils and increase their perceived attractiveness. As with the present study, it has also been found that emotional facial expressions in the viewer can be evoked by subliminal presentation of emotional face stimuli (Dimberg *et al.*,

2000). But the fact that we have no voluntary control over our pupils makes them an especially good measure of automatic emotional response, and the short latency of their change makes this measure in many ways superior to measures such as skin-conductance response or heart rate in psychophysiology. Aside from its theoretical importance, the study by Harrison *et al.* is likely to encourage future experiments to include pupillometry as a psychophysiological measure, since the technology to measure pupil size accurately is now widely available—even within the environment of fMRI experiments (as was in fact done in the study).

Several further questions are raised by the findings of Harrison *et al.* First, why is the influence of pupil size so specific to sad faces? Effects on happy, angry or neutral faces were not found. Second, is it pupil size as such or some other aspect of the eyes that drives the effects reported? One possibility might be that eyes with smaller pupils would necessarily have larger whites (the authors digitally adjusted pupil diameter in their stimuli without altering any other aspects of the eye) and that the slight increase of the area of the whites of the eyes is responsible for the findings rather than the slight decrease in the size of the pupils. In line with this alternate explanation, it has been reported that the amygdala, one of the structures also found to be activated in the present study, is activated by larger eye whites that signal fear (Whalen *et al.*, 2004). Future studies could independently manipulate pupil and scleral size to address this issue.

Finally, the different contrasts and correlations reported in the study raise the question of what causes what. Perhaps certain brain activations (amygdala and visual cortices) responded to viewing the sad faces and triggered signals in the diencephalic autonomic nuclei, which in turn changed the viewer's own pupil size. However, the change in the viewer's pupil would also result in different visual input, possibly causing some of the changes in the brain activation seen. Also notable is that the effect of pupil size on emotion judgments, and its effect on viewers' pupils and brain activations, was carried out in two separate groups. The subjects in the scanner did not judge the emotion of the faces. This unfortunately made it impossible to examine possible relationships between the perceived emotion of

the face stimuli and the pupil size or brain activation of the viewer. Would those subjects showing the largest responses in their own pupils also make the most sensitive emotion judgment about the faces they viewed? Such data would help to implicate causally the pupillary changes in the viewer in influencing emotion judgment.

It would be important to establish the actual distance at which the reported effects could occur in real life, and the kinds of social interactions that would predominate at such social distances—perhaps especially ones that are aggressive, maternal or sexual. It remains a puzzle why sadness alone was the emotion modulated by pupil size in the present study. Presumably, the causal effects in real life include both viewer and signaler: one could imagine a kind of positive feedback whereby looking at another person who is sad makes our own face look sad. These ideas could easily be explored in future experiments, for instance, by simultaneously monitoring pupil size in two subjects who are socially interacting at various distances.

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